Biomass Suspension Combustion: Effect of Two-Stage Combustion on NOx Emissions in a Laboratory-Scale Swirl Burner - DTU Orbit (13/04/2019)

A systematic study was performed in a suspension fired 20 kW laboratory-scale swirl burner test rig for combustion of biomass and co-combustion of natural gas and biomass. The main focus is put on the effect of two-stage combustion on the NO emission, as well as its effect on the incomplete combustion. When two-stage combustion was applied, the NO emission level can be significantly reduced. The experimental results show that an optimal first-stage combustion stoichiometry ($\lambda_1$) exists, at which a minimum NO emission can be achieved. An optimal stoichiometry of around 0.8 in the fuel-rich zone exists with respect to minimizing NO emissions. When using wood and straw as co-firing fuels, 15–25% of the fuel-N is converted to NO. Straw appears to give the lowest conversion of fuel-N to NO. The results indicate that the optimal stoichiometry in the fuel-rich ($\lambda_1$) zone for gaining the lowest NO may result from the homogeneous reaction, by comparing the NO emissions when firing natural gas with NH3 addition and co-firing natural gas and biomass. The experimental results also show no significant increase of incomplete combustion of gas and char by applying optimized two-stage combustion.